Steps Towards Sustainability and Decarbonisation: The Impact of High Recycled Content on High Formability Products

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Basic Oxygen Furnace/ Blast Furnace ⇄ Electric Arc Furnace

The EAF is becoming an increasingly more favourable route in steel production with regards to its less intensive energy consumption and environmental benefits in comparison with the traditional BF/BOF route. This alternative route is similar in operation, though with less steps [1]:

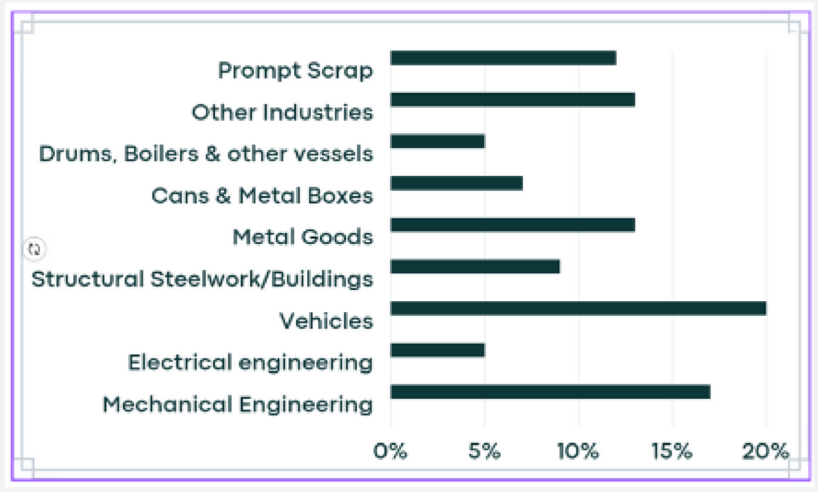
- ❖ Careful selection and arrangement of the scrap steel for the melt
- ❖ Electrodes are lowered, into the melt, to strike an arc
- ❖ Graphite electrodes are lowered further into the steel scrap with a transitional voltage tap being supplied
- ❖ The energy and length of the arc are increased, until it is stabilised.
- ❖ Once all the scrap is melted, the process is similar to that of the BF/BOF route

The benefits for switching are reduction in carbon dioxide emissions per tonne of crude steel. BF/BOF route ~1800kg of emissions per tonne of crude steel compared to 500Kg from the EAF route and approximately up to 20% of steel scrap can be utilised within the BF/BOF route whereas up to100% of steel scrap can be processed as the iron-bearing charge in EAF.

Recycled Steel ⇄ Residual Elements

❖ Scrap steel arises from many different sources and after this recycled steel is processed via sorting and shredding it is shipped to steelmaking facilities. Within this scrap steel lies residual elements, at quantities unwanted and often detrimental to the final product, as well as steps during the manufacturing stage

These include:



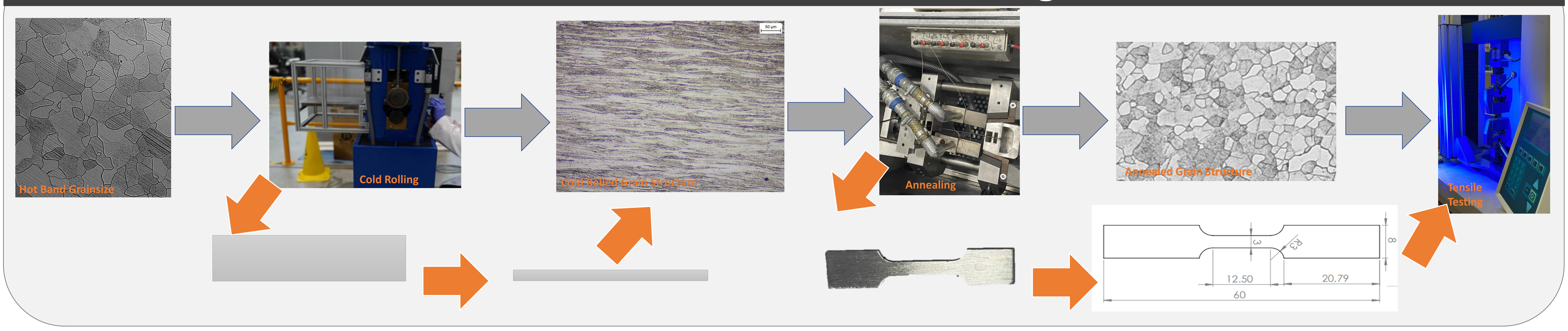
- ❖ Ni (steel coatings)
- ❖ Cu (structural steel, electrical wires, bearings)
- ❖ Pb (paint colouring agents, bearings)
- ❖ Sn (coating on cans, bearings, solders)
- ❖ B, Nb, Mo, V, Cr, Ti (generally found as alloying elements within steel scrap, E.g. Stainless)

❖ It's critical to understand the role of residual elements and how cracks and grain boundary segregation are formed at the casting stage, as it's the crucial step between liquid steel stage and the downstream steps.

Hot Rolling [Plant Material] → **Cold Rolling** → **Annealing [Gleeble Simulations]** → **Tensile Testing**

- ❖ IF Steel hot rolled from Tata Steel
- ❖ Cold Rolled reduction profile 80%
- ❖ R-value found via Mini 1 tensiles

Thermomechanical Processing



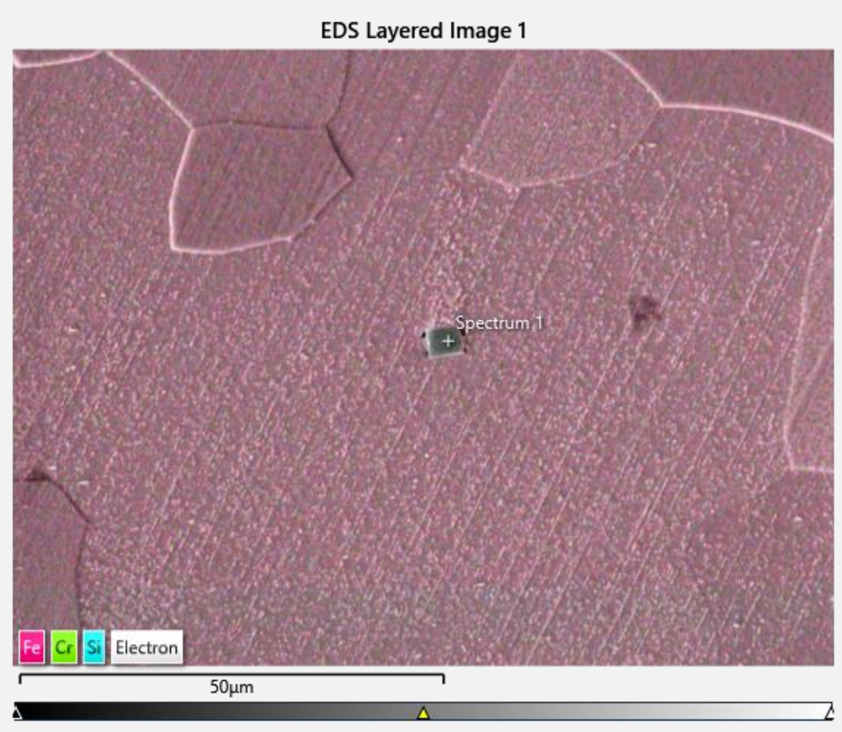
Microstructure & R-value

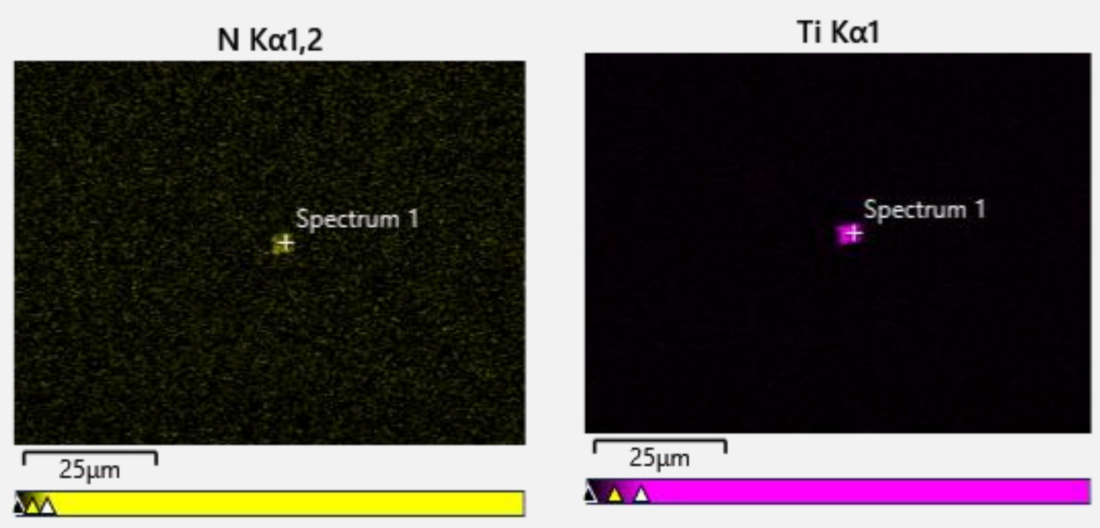
Cr Composition wt.%	Hot Band Grain Size um	Annealed Grain Size um	R-Value
0.017	24.5	17.4	2.17
0.06	19.7	13.6	2.13
0.07	25.6	19.9	2.07

Cr Composition wt.%	Annealing Temperature °C	R-Value R-20%
0.017	800	2.17
	820	2.28
	840	2.37
	860	1.8
	880	1.97
	900	1.67

Microscopy and Microstructure :

- ❖ EDS analysis for TiN
- ❖ SEM/Optical microscopy for grain size analysis





Future Work:

- ❖ Intrap Study with Cr, Ni, Cu and Sn
- ❖ Various Annealing temperatures for higher Cr levels, repeats & comparisons
- ❖ EBSD analysis on grain orientation

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